1**In January 1997, Jerry Linenger, MC, Joined the crew of the Russian space station Mir. Replacing John Blaha, Linenger became the fourth US. crewmember on the Russian space station. During his 5-month stay, the Navy flight surgeon's second space mission, he added to the knowledge base considered essential for the upcoming construction of the International Space Station. His visit was anything but routine. The 11-year-old Mir was showing its age. Frequent breakdowns in the station's systems fueled a controversy as to whether the United States should continue to participate in the joint space venture. Balky oxygen generators required frequent maintenance, an obsolescent computer malfunctioned, and a dangerous fire nearly proved fatal to the crew. Nevertheless, Linenger performed many useful experiments and, as Mir's resident physician, monitored his own as well as the health of the cosmonauts. Navy Medical Department Historian interviewed Linenger at the Johnson Space Center, Houston, TX, November 13, 1997**.

Why were you selected for a Mir mission?

When I finished my last mission, the Chief of the Astronaut Office called me in and said, "Jerry. Great mission. You did a nice job. We're all proud of you." He then asked me if! was still interested in a long duration mission and told me I was their choice if! still wanted to do that. I told him I was interested but I wanted to talk it over with my wife and find out if she wanted to go to Russia for a year and a half if I accepted a 4or 5-month mission to a space station. She was ready to travel a bit and it sounded good so I accepted a prime spot on one of the upcoming flights. I took a week's vacation and headed for Monterey to the Defense Language Institute for about a month and a half. Then we went right over to Russia.

How did the language studies go?

I had instructors in Russian language from one of the universities in Moscow. They came out to Star City, where we trained. I took Russian language in the morning and in the afternoon I'd learn the different space systems–life support systems, and all the complicated space material. It was definitely feet first. You' re struggling with the language and at the same time you're getting all your systems training. The last few months, you finally reach critical mass in both Russian language and systems and that's when you really cram. All of a sudden, you can ask the right questions because you've got the language capability. It took about a year and a half before I felt comfortable with the language and really knew the systems well enough to go on the mission.

And you used only Russian on the mission.

A hundred percent Russian on the station. The cosmonauts could help me out with a word or two. For example, if I didn' t know the word for

telephone, I'd say it in English very slowly and sometimes they could help me out. Among the crew, communication was very good and they probably picked up many of my grammatical errors and learned to live with them. Communicating was the key, not my grammar.

What was Star City all about?

It's an old KGB closed base--top secret about 45 minutes from Moscow. It wasn't on the map back in the Cold War days. lt's still a gated city and it's very much the way you picture communal living. lt has its own gym, its own dining hall. People live and work there. There's no off-base living. It's a little community along the lines of the old communist model, and totally insulated from the rest of the country. But it 's also very beautiful. Star City was built in an old northern woods with a lot of birch trees and paths going through the woods. Almost everyone there has a Dacha--a little cabin on a plot of land where they grow potatoes and vegetables during the summer.

What was a typical day of training?

A typical day included a few hours of Russian language, a few hours of studying life support systems, and in the afternoon, working simulators. Occasionally, we took a bus ride to an off-base facility. We might go inside a vacuum chamber, for example, or go into Moscow to be fitted for your spacesuit. And then I studied at night, trying to learn the language and the systems. They were very full, busy days.

Is their training different from ours?

It 's very different. There's very little interchange and very few modern learning tools like computers. The training is definitely noncomputer-based learning. The job of trainers here is to impart the information and then you go back and forth with discussion. It's much more give and take. In Russia, the teacher is simply a lecturer. The actual teaching uses standard texts, much like we were schooled 30 years ago. For example, to test you, they bring in a board of 10 or 12 experts from the companies that build the space ship and they grill you with questions. It's an oral board.

Was the flight on the shuttle up to Mir similar to your previous flight?

It was in the beginning, but your perspective changes. After Russia, I came back to Houston for shuttle refresher training and that was barely a drop in the bucket as to what the flight would be. Shuttle time was 5 or6 days and Mir time was 132 days. The main purpose of the shuttle was just to get me up to the place where I was trained to do my job. I was really the payload--the satellite.

How was the rendezvous and docking with Mir?

Impressive. The space shuttle Atlantis is coming up at 18,000 miles per hour docking with tolerances of just inches. You have to be within 2 inches for the docking ring alignment. You need to be within 0.1 foot per second oft he speed you want closing between the two vehicles. Even though it's a huge spacecraft, the shuttle goes up there rock steady and just kisses the space station Mir. You can't help but be overwhelmingly impressed with the way the shuttle can perform that mission. After the docking, they open the hatch and it's like going to sea and you 're trying to get all your supplies on board.

How did you feel when you realized you would be leaving your colleagues behind for a long time?

Well, you've got a lot ahead of you and so I wasn't looking behind; I was looking ahead and trying to do a good changeover with the American who was up there--John Blaha. It was like a handover in the Navy when you take over someone's job. You're really not thinking of what you did previously, but rather what's down the road. Emotionally, it probably peaked when I looked out the window after they departed. I took a deep breath and said, "Well, I' m up here now and committed, and I'm going to be here for the next 5 months and that's all there is to it. There goes my ride heading home and I'm not on it." You feel a sense of closure but by the next morning you're ready to get going because there's a lot to do.

What were some of those first projects?

A lot of it was activating the different science experiments, some of which would run the entire time I was up there. One of the first was getting the dosimeters operating so we could get a total time course of radiation dosage. Air sampling was another. Surface sampling would give us a look at the initial flora and see how that changed over time. So I was very busy, especially with the experiments that would continue throughout the entire 5 months.

Were these continuations of experiments that John Blaha had started?

Some were continuations but for the most part, it was a brand new science program. There was a definite break in the science between John's flight and mine. My science program was much more linked to the person who followed me--Mike Foale. Ninety percent of the experiments were new. John packed up his gear and returned it and I unpacked new experiments.

How about the medical experiments?

Sleep study was an interesting one. You can imagine you're going around the planet every 90 minutes, so every 45 minutes you have either sunrise or sunset. Circadian rhythms are messed up, to say the least. I would sleep with eyelid sensors on to look at my rapid eye movement sleep versus my deep sleep. And I would sleep a couple of nights a week with

electrodes over my entire head looking at brain wave patterns of sleep. I would do about five mood surveys during the day looking at body temperature, very similar to the work we were doing out at the Naval Health Research Center in the sleep deprivation studies.

Were you doing this on just yourself or also on your colleagues?

I learned to do this on myself and I also learned to draw my own blood and be self-sufficient. If I needed help I always had everything totally prepared and then I would ask one of the cosmonauts to do something for me. l always tried to respect that they had projects and they also respected my time. Of course, with a lot of the system breakdowns, I would have to work the science in around repairing oxygen generators and things vital for survival. We had to work together on those systems and we'd divvy up the work. But throughout the mission, I would always try my best to carry out the science programs and meet all the objectives.

Were the cosmonauts ever subjects for your medical experiments?

They also did some of the sleep studies and I would help rig them up. Usually, with most of those experiments, Americans were the principal investigators from different universities around the country. And I was the prime person to ensure they were carried on properly.

I'm sure they felt pretty good having a doc aboard.

It was very reassuring to them, especially with our share of problems. For example, we had problems with ethylene glycol vapors leaking, and temperatures soaring above 90 degrees and high humidity for over a month. These things had medical effects. And the cosmonauts were very glad that I was a trained physician. I did a lot of treating up there. So the local atmosphere turned out to be a major problem. The fundamental things you need to be concerned with is ensuring that you have breathing air, that you've got carbon dioxide scrubbed out, and you don't have contaminants in the atmosphere. With system failures, all of those became concerns. From time to time we had to wear filter masks throughout the day. I was very busy medically, busy as a scientist, and busy as a cosmonaut doing repairs on the station. It was as hard as I've ever worked in my life. It was literally 24 hours a day, 7 days a week. Of course, a week is hard to define because there’s really no marker of time. We artificially used Moscow time on our wrist watches. l’d shave every Sunday morning to help mark the week. And shaving is not trivial. It takes 45 minutes or so to shave with a straight blade because you have to wipe every stroke of your beard into a towel to keep it from floating. You either do it that way or else you will be breathing your whiskers.

Did you regularly have contact with Houston during the mission?

I had no contact with Houston the entire time. People think you're up there chatting away with the ground, but you're really not. The only communications we had were with Mission Control in Moscow. There was a small group of NASA representatives there and every so often I would be able to talk to them but that was pretty rare. In general, our communications passes were very limited, maybe 5 minutes every 90 minutes if we were lucky. Sometimes we didn't even have that. And most of that time was spent with controllers giving us repair instructions. So I had very Iittle opportunity to speak with the NASA side, and therefore I had very little opportunity to get any feedback on the experiments. I had 5 months of doing experiments and trusting my own training and educational background with very little feedback and very little help from anyone.

So most of the things you did required your coming back before you could evaluate results.

That's right. You pour your heart and soul into your work and put in long hours so you are definitely keeping your fingers crossed post-landing. Did the computer record the results correctly? Did I load the film correctly? Was my exposure set correctly? Feedback is a good thing and when you have to wait 5 months for it it's a disadvantage.

In reality, we did very well. We had 100 percent success in all the science we carried out; we were able to get it done despite all the other difficulties we had up there despite all the time doing repairs and space walks. As a matter of fact, we ended up with more pictures than I took up film for. And that worked out because I found some floating film behind a pane that Shannon Lucid had left behind. That's over a hundred percent success!

When you were in Washington at the Surgeon General's Leaders' Conference, you talked about some of your feelings looking down at the earth and seeing evidence of man.

The earth is magnificent. But signs of man are very evident. Flying over South America, I could see a thousand points of light--fires where they were clearing the jungle. The smoke pall traveled halfway across the Atlantic Ocean. The same thing in Mongolia. There, they are clear-cutting the forests and burning. In China I tried to get a picture of Beijing, but for 5 months I could not get a clear picture because of the combination of either smoke, clouds, or smog. Every city is a gray smudge on the surface. Every city--1 don 't care if it's known for its parks or whatever, from space every city is a gray blotch. You can definitely see the effects humans have had. It's ugly. The land is denuded and you can see all that plainly from space.

Did you get a chance to look in the other direction-up toward the sky? Could you see Hale-Bopp?

Hale-Bopp was a huge flash light just dominating the entire sky. Sometimes, before bedtime, I' d look at the stars. You can see millions of stars and it's mind-boggling. When you're in space and look out you see so

many stars, your mind tells you there's a high probability that there' s some other form of life out there.

You talked about communication and the fact that it was very limited. How about with your family? Did you have things like email?

My wife came to Russia to try to improve our chances of being able to talk. They did have the capability to do a video downlink and uplink where it would be possible for me to see her and she see me. But that system had only one successful pass in 5 months. Email was possible. I would tag my personal email to the end of experimental results but the down link for that was maybe once a week if we were lucky, and you had to limit it to about 5K. So I would use elementary word processing and little short notes. We had about a 2-week lag between anything I sent her and any response. Eventually, I got to the point where instead of getting frustrated I changed my attitude. I had to realize that I was out on the frontier; I' m an explorer and it's very similar to the exploration of old where you went out on a ship at sea and were gone for 5 months. Then you caught up on things when you got back. With that attitude, it was easier to tolerate the lack of communication.

We were listening to the letters to your son John on National Public Radio. How did those come about?

I usually wrote a letter to my son every night before I went to bed. As things got more serious up there my letters became more serious. I think I was trying to pass things along to my boy in the event that something bad might happen. I typed them on the computer in elementary word processing and then I'd try to send it down at the back end of data files from experiments. In Mission Control Moscow, my NASA group would peel those off and send them to my wife. When people became interested, I agreed to put them on the Internet. And then NPR heard about it. So they had me read one during communication passes once every few weeks.

You've already alluded to the level of Russian technology.

Here was a space station that was 11 years old. Russian technology is brute strength mechanical engineering and that's the big difference between our space products and theirs. It's pretty good mechanical engineering when you think of some of those systems lasting 11 years. But at this point, it's like an old car. More and more time is spent keeping the car running. It's the same thing with a space station. Mechanical parts break down and you spend more and more time as the years go on taking care of the systems. Unfortunately, that means less time to do your productive work--the science, the space operations.

You had some harrowing experiences. One involved a rendezvous and docking with a Progress rocket and the other was the fire.

We had three occasions when we were ready to evacuate and had the Soyuz-the rescue vehicle-ready. One was near-collision with the Progress, one was the fire, and the third was a combination of oxygen system and carbon dioxide scrubber failures, and lack of backup canisters. The last crisis was a supply sort of thing. We started counting our supplies and realized we needed more canisters in a resupply vehicle or we wouldn't be able to stay up there breathing.

I've talked a lot about the fire and I think most people know about it. It was a 15-minute, 2-foot, blowtorch-like directional fire in an oxygen canister so it had fuel. You're in a closed environment with nowhere to go, and it's like being shipboard in the middle of a battle. You've got a fire and you have to fight it. Aboard ship, you can escape to the deck. In this case, you couldn't open a window and there was literally nowhere to go. How did you fight it? Step one was to make sure we were going to survive to fight it so we put on our oxygen respirators. Smoke got very dense very quickly. Within 30 seconds you couldn't see your hand in front of your face and you couldn't breathe the atmosphere. In space, smoke doesn't rise; you're weightless and the smoke is also weightless so there's no clear spot down low. Once we got our respirators on, two of us grabbed fire extinguishers and started fighting the fire like you would on earth. However the fire extinguisher acts as a thruster up there so we had to brace ourselves in order to fire it.

What kind of extinguishers were they?

Water-based. Again, it would be nice to have other fancy things, but everything would end up in our atmosphere. So you can't have any fancy gases that might be toxic. The water in our extinguishers turned into steam because that fire was burning at probably twice the melting point of aluminum. We were not going to put it out. All we could do was contain it and keep the secondary structures from igniting by using the extinguishers. We also cut off the fans throughout the space station so the air would not circulate. In that micro-environment, the fire eventually was starved of oxygen. For example, a bulkhead would start to burn and then it would put itself out because the oxygen was not replaced. Because warm air didn't rise next to the fire, fresh air didn't come up next to it. Therefore, in that micro-environment, you get a boundary layer devoid of oxygen and full of burn products.

What was the aftermath?

I' d call it a medical emergency. I set up a tracheostomy station and had all the gear out. I kept everyone on the respirators as long as possible while the environmental support systems were helping clear the air. The condensate from the water vapor on the cold hull took a lot of the soot and particulates out of the air. After that, I put 3M filter masks on everyone and started listening to lungs, getting percent oxygen in the blood on everyone, and setting up a baseline. I was also concerned with contamination control.

Everyone washed, and we bagged all the components that had burned to keep the more toxic particulates from getting into the air. I did the best I could to isolate that material. I did about 48 hours worth of exams on people and took air samples. I also stored air samples in a vacuum cylinder to measure how well the atmosphere was doing for post-flight analysis. I wanted to see what we had been exposed to. I also treated a few burns.

Did the atmosphere pretty much clean itself up in time?

We stayed in the 3M industrial filter masks about 48 hours. The problem was we simply didn't have enough respirators with oxygen. We wanted respirators ready should there have been a second fire. So we chose to go with the filter masks, even though there was some remaining smoke.

In an environment like that where things are breaking down on a regular basis, it seems that all of you were being stressed to abnormal limits.

It's like being aboard a ship at war and you've taken some damage. You've got a few flooded compartments and some broken gear, and you've got a threat around you. That's a good earth analogy to what it's like to live up there and what your concerns are. When you have a fire and a near miss, you realize anything can happen at any moment. When a master alarm goes off you' re right on top of it.

How was your own psychological health?

I kept very good account of my own psychological health and I think I held up very well. My Navy training and background paid off, especially in dealing with the stress of isolation, although isolation was almost minor compared to the other life-threatening things I'm talking about. I also realized that any action I took could have very serious consequences, especially if l made a mistake. For example, disconnecting the wrong cable, pushing the wrong button. Those things can lead you into a downward spiral.

You had your first EVA (extravehicular activity) while aboard Mir.

You open the door and it's very similar to climbing out on the wing of an airplane. All of a sudden you feel the speed. Inside the station, you know intellectually that you're going fast. You're seeing cities going by every couple of seconds. But when you open the hatch and climb out on the convex exterior of a space station, you feel like you're falling off a cliff and all of a sudden you get the sensation of 18,000 miles per hour. And I've never gone 18,000 miles an hour, at least not outside! It's an overwhelming feeling. Based on your training and because you've been in tough situations before--flying on carriers and doing all the things we do--you learn to compartmentalize that fear away. You still have the feeling of going 18,000 miles an hour and falling off a cliff but you are able to tuck it away and get

the job done over the next 5 hours. But I will never forget doing that spacewalk. lt was the ultimate bungee jump.

During your first flight aboard the shuttle you used the treadmill for exercise. You also used a treadmill aboard Mir but using it was a real chore.

Exercising is not fun in space. Your body likes floating. It likes being under non-stress. Twice a day, for 1 hour each time, you have to strap yourself in and yank down on your shoulders with 70 kilograms to hold yourself in place. As the treadmill gets turning and you start running, your body revolts and says, "I'd rather keep floating." Sometimes you feel like you have pins being driven into the soles of your feet. They're not used to the pressure. You're constantly readjusting the harness because it's yanking down on your shoulders or grating on your hip. It takes dedication to work out during that 1-hour period twice a day. But you have to do it. It's important for your health. It was also important for me to be able to walk off the shuttle at landing. You have to keep yourself in shape and do the best you can to counteract what is essentially bed rest for 5 months. Actually, it's even worse than bed rest because you're getting absolutely no resistance whatsoever. I worked very hard at it and tried very hard to conserve my bone mass. That's another thing that suffers in the space environment.

Were the cosmonauts as religious as you were about exercise?

They carried on their program, but not as religiously. I think there still are some cultural differences. In Russia, you don't see many people jogging at lunch. Tobacco use is probably a lot higher over there than here. Russians are not used to exercising even on earth and when you get in space it's a lot tougher to do it.

What was the food situation aboard Mir?

I ate a lot of Russian food out of tubes-jellied fish, borscht. I also had American food aboard. We had almost a 50-50 mix of shuttle food and Russian food. To be honest, any food that was different after 5 months tasted good.

What did you want to eat when you came home?

I think I asked for some good old meatloaf and potatoes. When you come back, your gyros [gyroscopes] are not synched quite right so when you move your head a little bit you get some spin sensation. I think it's safe to say that I was probably a bit disappointed with my first meal. When I came back I was content to have a light meal and wasn't ready to chow down quite yet.

When it was time to come home, you must have been chafing at the bit.

There are great Navy analogies to all ofthis because it's the same kind of isolation being away from family and friends. If you go out on a cruise and you know it's going to last 6 months, you set your mind to go through 6 months. I did the same thing. I knew I had a 6-month mission and in my mind I was going to make it from start to finish. I was busy and productive the whole time. I never said, "I've got to get off this thing." I was working very hard right up to the very end. If there had been a delay in the shuttle launch, I think that would have been tough to handle. Near the end you start marking the days off the calendar but you work hard from start to finish and you try to complete the thing right.

How did you feel when you saw the shuttle coming toward you?

Fantastic! Total elation. I twas pure joy to see the space shuttle coming up. First of all, it was spectacular to see it. And in my case, it was my ride home. I was keeping my fingers crossed that everything went well during docking. Once the hatch opens, you keep yourself close to the shuttle at all times. In case of an emergency I was definitely going to end up on the shuttle side of that closed hatch!

Because of your physical condition, did you feel any different about this homecoming reentry than you felt during your first shuttle flight?

I was in a recumbent seat instead of sitting upright and because of that I had no hypostatic problems whatsoever. No. I didn't feel much different than a shuttle reentry after 10 days. Post landing, it was tough getting up and walking but there wasn't a huge difference from shuttle landings after 10 days. It's an individual thing. If you were an outside observer watching the crew getting off, at least immediately after landing, you probably wouldn't pick me out as being any different than the other crewmembers. However, the recovery after that is a different story. I was in space 5 months and it took about 5 months to get back where I could go run and lift weights and feel normal again.

How about bone loss?

I had bone loss and haven't made up for it yet. I recently had a DEXA scan followup. For example on the hips, I was down around 12 percent and now I'm sitting around 7 percent. And that's 5 months out. It's going to take time. I'm working out hard trying to get it back mainly with weight training at this point. I did a lot of water training early on to avoid getting stress fractures. Walking came next, then slow jogging, and now l'm lifting more and more weights. Does it feel any different in my hips? Not really.

Any other changes that you notice besides bone loss?

One of perception. I'm still three dimensional on earth. When I look at a building, I see volume not floor space. So if l give a talk in a large auditorium I think, "Wow I could put 100,000 people in this place!" I still

see the ceiling as a viable place to sleep. So I haven totally shifted my perspective back to two-dimensional. I'm waiting for it to click in one day.

We have another astronaut up there now and another going up after him. Do you think the Mir missions are still worth the effort?

We've gotten a lot out of the Mir missions. You've got to be out at sea to really know what it's like to be out at sea, and you learn things everyday. It's the same thing with space. You learn things every day inspace. We're gaining valuable experience. On the other hand, I'm looking forward to the new space station. There will be fewer maintenance needs and more science can get done.

You are retiring in December. What's in store after that?

I have had a great stay in the Navy but now I want to live in a place of my own choosing and not dependent on a job. I also want to spend some time with my family. Medicine is not an option right now nor is anything further in the space program. I want to do something that's fun in the sense of a steep learning curve, but there are no hard plans right now in terms of a particular job. I guess it's hard to top flying in space. That's true. I've done a lot of traveling--2,000 orbits and 50 million miles. Staying put for awhile, having some home-cooked meals, and not sucking food out of tubes sounds pretty attractive.